Report for 2001CA3961B: Hydrodynamics of Shallow Water Habitats in the Sacramento-San Joaquin Delta

- Other Publications:
  - Baek, S. and Stacey, M., Steady-state salinity of shallow water habitats adjacent to a tidal channel, Journal of Hydraulic Engineering. In Press.

Report Follows:

Hydrodynamics of Shallow Water Habitats in the Sacramento-San Joaquin Delta

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Project Summary

The exchange dynamics between shallow water habitats in the Sacramento-San Joaquin Delta (the Delta) and the adjoining channels have been analyzed using numerical simulations. These modeling activities focused on: (1) determining the salinity of shallow-water habitats adjacent to tidal channels and how the salinity depends on the geometry of the opening; and (2) exploring how temperature variations in the Delta alter these channel-shallow exchanges.

Shallow-water Habitat Salinities

The development of a shallow water habitat adjacent to northern San Francisco Bay (the North Bay) usually begins with the creation of an opening in a levee adjoining a tidal channel in the bay. For ecological considerations, the resulting salinity of the shallow water habitat is of critical concern. One difficulty in designing these habitats lies in the fact that the salinity in the channels of the North Bay can vary by 5-10 parts per thousand on the tidal timescale through the advection of the salinity field by tidal currents. As a result, the timing of the exchange of waters between the channel and the shallows relative to the tidal currents in the channel will largely determine the mean salinity of these "off-channel" habitats.

To address this question, we have focused on an analytic solution, which will be most useful for management considerations. The approach is to link two one-dimensional solutions to predict the timing of the average flow between the channel and the shoal. The first is a simple tidal model of the flows and salinities in the channel, which includes as a prescribed parameter the phasing between the tidal stage and the tidal currents. The second model is a one-dimensional parameterization of the exchange flows between the channel and the shallows, which are driven by the difference in stage between the channel and the shallows, but is resisted by a frictional force that will depend on the geometry of the opening. Solving the cross-sectionally averaged momentum equation for the exchange flow, we determine the timing and salinity of the waters flowing into the shallow water habitats as a function of the mean channel salinity, the salinity gradient along the channel, the phasing of currents and stage in the channel, and a drag coefficient for the channel-shallow transition.

The solution indicates that the salinity in these shallow off-channel water bodies will exceed the mean channel salinity by as much as several parts per thousand, due to the timing of the exchange flows, but depends on the geometry of the transition through the integrated drag coefficient. To determine appropriate values of the drag coefficient, we used the three-dimensional hydrodynamic model, TRIM3d. The model was run for an idealized channel-shallow geometry for four different geometric cases . The results of the three-dimensional simulation were integrated to reproduce the one-dimensional parameterization used in the analytic solution, and each term in the one-dimensional equation was evaluated to determine

the average drag coefficient. The salinity in the shallow water habitat may change by as much as 5 parts per thousand depending on the geometry of the transition. From a management perspective, this may provide a mechanism for controlling the salinity in the shallow-water habitat. For a given geometry, these results would determine the optimal location for the shallow-water habitat, in order to achieve desired salinities.

Temperature Effects on Exchanges

In September 2001, using direct hydrodynamic observations, it was seen that the exchange between Mildred Island and the adjoining channel was generally a typical jet-structure during the flooding tide . However, on warm days, the jet structure was modified during the afternoon due to the effects of temperature stratification and wind. As a result, we have begun development of a temperature module for use in TRIM3d. This activity is still underway and will continue under funding received from CALFED.

Publications

Baek, S. and Stacey, M., Steady-state salinity of shallow water habitats adjacent to a tidal channel, *Journal of Hydraulic Engineering.*

Professional Presentations

Stacey, Mark, Mildred Island, Lake, Lagoon or Estuary. What is it?, . PI Organizational meeting for CALFED funded activity, USGS, Menlo Park, California, February 6, 2002

Student Training

Seungjin Baek, M.S./Ph.D., Civil and Environmental Engineering, UC Berkeley.

Additional Funding

The three-dimensional modeling work begun under the WRC funding has led to a longer-term collaborative study with the USGS and funded by CALFED for $113,000.

Collaborative Efforts

The Mildred Island study was a collaboration with the USGS which occurred in advance of the CALFED funding described in the previous section.